METHOD AND APPARATUS USING LIGHTWEIGHT RRQ FOR EFFICIENT RECOVERY OF A CALL SIGNALING CHANNEL IN GATEKEEPER-ROUTED CALL SIGNALING

FIELD OF THE INVENTION

The present invention is directed to a method and apparatus for efficiently recovering an Internet protocol realtime data communication signaling channel.

BACKGROUND OF THE INVENTION

Packet data networks are increasingly used for the exchange of realtime audio, video and data communications. The H.323 protocol requires the establishment of a call signaling channel that is separate from the bearer channel. The call signaling channel is used to exchange signaling messages, such as call setup, tear down, address translation and messages related to billing.

In a gatekeeper routed system, a call signaling channel is established between an end point or terminal and a gatekeeper. The gatekeeper is an entity that provides basic call signaling features, enhanced features, address translation, network access control and other functions. The call signaling channel between the end point and a gatekeeper must be maintained in such a system if realtime communications between the terminal and any other terminal are to occur or continue.

Alternate gatekeepers may be provided by a system in case the call signaling channel between the terminal and the gatekeeper with which the terminal was initially registered fails. However, the ability to re-establish the call signaling channel with an alternate gatekeeper is not assured. For example, one or more alternate gatekeepers may not be reachable or may be down. Accordingly, an alternate gatekeeper that is actually

available must be found. One approach to locating an available gatekeeper is to attempt to re-establish a transmission control protocol (TCP) connection with each address in the alternate list, one at a time, until a gatekeeper that is actually available is found. However, attempting to establish a TCP connection with each gatekeeper in the alternate list can be an extremely time consuming process, especially when a successful connection is only established towards the end of the list. A TCP connect message could be sent to multiple gatekeepers on the address list simultaneously. Such an approach could make the process of locating a gatekeeper that is actually available faster, however, it is not particularly efficient, as it could result in the generation of excessive network traffic. Furthermore, multiple TCP connections could be established, and then all but one would need to be torn down. Accordingly, needless overhead could be generated. With respect to either of the approaches in which a TCP connection is established, following establishment of the connection, messages need to be exchanged to make sure that the terminal is still registered with the gatekeeper.

Another approach to re-establishing a call signaling channel is to use a "ping" to determine if a gatekeeper is up. However, the use of a ping for this purpose is problematic in situations where the gatekeeper is behind a firewall, as some firewalls filter out the ping message. In addition, as with approaches that seek to establish a TCP connection, additional messages would be required in order to determine if re-registration is necessary.

SUMMARY OF THE INVENTION

The present invention is directed to solving these and other problems and disadvantages of the prior art. According to the present invention, a lightweight registration request (lightweight RRQ) message is sent by an end point or terminal when a call signaling channel is lost. According to an embodiment of the present invention, the lightweight RRQ message is sent to one or more gatekeepers corresponding to addresses on an alternate call signaling address list established for the end point. Each alternate gatekeeper that receives the lightweight RRQ message sends back a registration confirmation (RCF) message. The receipt of an RCF message by the end point indicates that it is very likely that the end point will be able to establish a call signaling channel with the alternate gatekeeper(s) that sent an RCF message and indicates that the end point is still registered with the gatekeeper(s).

If the end point receives a registration rejection (RRJ) message with a reason code of "discovery required," and does not receive an RCF message from any other alternate gatekeeper, the end point can terminate efforts to immediately re-establish a call signaling link. Instead, the end point can restart the registration process from the gatekeeper discovery phase.

These and other advantages and features of the invention will become more apparent from the following discussion, particularly when taken together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 depicts a realtime communication arrangement in accordance with an embodiment of the present invention;

Fig. 2 depicts the relationship of gatekeepers to communication endpoints in accordance with an embodiment of the present invention;

Fig. 3A is a flow diagram illustrating the discovery, registration steps and establishment of call signaling connection by an endpoint in accordance with an embodiment of the present invention;

Fig. 3B is a flow chart illustrating the steps taken to re-establish a call signaling channel in accordance with an embodiment of the present invention; and

Fig. 3C is a flow chart illustrating the steps taken to re-establish a call signaling channel in accordance with another embodiment of the present invention.

DETAILED DESCRIPTION

With reference now to **Fig. 1**, a realtime communication arrangement **100** in accordance with an embodiment of the present invention is illustrated. In general, the communication arrangement **100** involves first **104** and second **108** communication endpoints interconnected by a communication network such as an IP protocol communication network **112**. As can be appreciated by one of skill in the art, the IP communication network **112** may only comprise a portion of the communication link between a sending and receiving device. Accordingly, the endpoints **104** and/or **108** may comprise a gateway to another communication network, such as the public switched telephone network (PSTN). As can also be appreciated by one of skill in the art, where

the IP protocol communication network **112** comprises the entire communication link between the endpoints **104**, **108**, the endpoints **104**, **108** may comprise terminals. Examples of terminals include telephones, video phones or computers that are operable to provide realtime audio, video and/or data communications. Such terminals may be integrated into computing devices (e.g., a soft phone) or can be implemented as stand-alone hardware, (e.g., an IP telephone).

In accordance with an embodiment of the present invention, realtime communications between the endpoints **104**, **108** across the IP communication network **112** utilize the H.323 protocol. More particularly, the present invention has application to communications in which an endpoint **104** and/or **108** utilizes gatekeeper routed call signaling in connection with realtime transfer protocol (RTP) communications.

With reference now to **Fig. 2**, a gatekeeper zone **200** that may be utilized in connection with a communication arrangement **100** in accordance with an embodiment of the present invention is depicted. In general, the gatekeeper zone **200** comprises a number of gatekeepers **204**. In **Fig. 2**, gatekeeper 1 **204a**, gatekeeper 2 **204b**, and gatekeeper n **204n** are illustrated. However, one of skill in the art can appreciate that the present invention may be applied to any zone **200** having two or more associated gatekeepers **204**.

The gatekeeper zone **200** additionally includes a communication endpoint **104**. In **Fig. 2**, communication endpoint 1 **104a**, communication endpoint 2 **104b** and communication endpoint n **104n** are illustrated. However, a gatekeeper zone **200** having any number of communication endpoints **104**, including a single communication endpoint **104**, may be used in connection with the present invention.

The gatekeepers **204** and communication endpoint(s) **104** included in the gatekeeper zone **200** are interconnected by the Internet Protocol (IP) communication network **112**. The communication network **112** is a packet data network that is used to establish both call signaling channels between a communication endpoint **104** and a gatekeeper **204**, and a bearer channel between different communication endpoints (*e.g.* endpoints **104** and **108** in **Fig. 1**). In general, the communication network **112** comprises a local area network (LAN), wide area network (WAN) or combination of local and/or wide area networks.

Each gatekeeper **204** associated with the zone **200** provides various services to each communication endpoint **104** registered with that gatekeeper **204**. For example, when a communication (e.g., a voice call) is initiated, the gatekeeper **204** with which the initiating endpoint **104** is registered will translate the address entered at the communication endpoint **104** (e.g., a dialed telephone number) into an IP address. The gatekeeper **204** also provides services such as network access control, bandwidth management, accounting functions, and communication features, such as conferencing and call waiting functions. A call signaling channel must be established between the communication endpoint **104** and a gatekeeper **204** for the duration of a realtime communication between endpoints (e.g., between endpoints **104** and **108** in **Fig. 1**).

The communication endpoints **104** may, as noted above in connection with **Fig. 1**, generally comprise a hardware or software enabled device that provides realtime audio, video and/or data communications to and/or from an Internet protocol network **112**. Accordingly, a communication endpoint **104** may comprise a device that provides the content of a realtime communication directly to a user, such as a telephone or video

telephone, or that provides an interconnection between the Internet protocol communication network **112** and another network, such as a public switched telephone network, and therefore functions as a gateway. The data comprising a real-time communication provided by the communication endpoint **104** is sent to or from the communication endpoint **104** over a bearer channel that is established separately from the call signaling channel. As can be appreciated by one of skill in the art, the bearer channel is typically routed to another communication endpoint (*e.g.* endpoint **108** in **Fig. 1**) without passing through a gatekeeper **204**.

With reference now to **Fig. 3A**, the gatekeeper discovery and registration procedures that may be followed and the establishment of a call signaling channel in accordance with an embodiment of the present invention are illustrated. Initially, at step **300**, a gatekeeper request (GRQ) message is sent from an endpoint (*e.g.* endpoint 1 **104a**) to a gatekeeper **204** within the zone **200**. At step 302, a determination is made as to whether the gatekeeper 204 has rejected the endpoint 104. If the gatekeeper 204 has rejected the endpoint 304, a gatekeeper reject (GRJ) message is sent to the endpoint 104 (step 304). The endpoint 104 then sends a GRQ message to another gatekeeper 204 (step 300). Alternatively, the endpoint **104** may get no response to a GRQ message, in which case the endpoint may resend the GRQ message to the same gatekeeper **204**. This may be repeated several (e.g., 3) times, and if no response is received, the endpoint **104** may then send a GRQ message to the next gatekeeper **204** (step **300**).

If the endpoint **104** is not rejected by the gatekeeper **204**, the gatekeeper **204** replies with a gatekeeper confirm (GCF) message and a list of alternate gatekeeper addresses (step **306**). The endpoint **104** then sends a registration request (RRQ) message

to the registration, admission, and status (RAS) address contained in the GCF message (step **308**).

At step **310**, a determination is made as to whether the gatekeeper **204** has successfully processed the RRQ message from the endpoint **104**. If the gatekeeper **204** was not able to successfully process the RRQ message, a registration reject (RRJ) message is sent by the gatekeeper **204**. If the endpoint **104** receives an RRJ message in response to its RRQ message (step **312**), the endpoint **104** sends an RRQ message to an address in the alternate gatekeeper list (step **314**). If the endpoint 104 receives no response to the RRQ message (step **312**), it retries several (e.g., 3) times. If still no response is received, or if a RRJ message is received, the endpoint **104** sends a RRQ message to the next gatekeeper **204** (step **314**). The process then returns to step **310**.

If the gatekeeper successfully processes the RRQ message, the gatekeeper replies to that message with a registration confirm (RCF) message that includes the call signaling (CS) address for the gatekeeper **204**, a list of alternate CS addresses, and a time to live value specifying the periodic time interval within which the endpoint **104** must renew its registration by sending a light weight RRQ message (step **316**). When the endpoint **104** receives the RCF message, the RAS channel is considered to be successfully established.

At step **318**, a determination is made as to whether a keep alive signal (i.e., a lightweight RRQ message) is due. If such a message is due, a lightweight RRQ message is sent (step **320**). The process then returns to step **318**.

If a keep alive signal is not due, a determination is next made as to whether a CS channel is required (step **322**). If a CS channel is required, for example because a user is trying to originate a call from the endpoint **104**, the endpoint **104** attempts to establish a

transmission control protocol (TCP) connection to the CS address received as part of the RCF message. At step **324**, a determination is made as to whether the TCP connection to the CS address has been successfully established. If the TCP connection has not been established, a CS address is obtained from the alternate CS address list by the end point **104** (step **326**). The endpoint 104 then attempts to establish a TCP connection to that alternate CS address, and the system returns to step **324**.

After a TCP connection to a CS address has been established, the CS channel is in place. The system then determines whether the CS channel between the endpoint **104** and the gatekeeper **204** has been lost (step **328**). If the CS channel has not been lost, the system returns to step **318**. Although the step of determining whether a CS channel has been lost is shown as occurring at a discrete point in time, it should be appreciated that the existence of the signaling channel may be monitored by an endpoint **104** continuously.

With reference now to **Fig. 3B**, steps that may be taken to re-establish a signaling channel in accordance with an embodiment of the present invention are illustrated. Accordingly, if at step **328 (Fig. 3A)** it is determined that a call signaling channel with the gatekeeper **204** that the communication endpoint **104** had been registered with is lost, the communication endpoint **104** may proceed to step **344**. At step **344**, the communication endpoint **104** selects a next gatekeeper **204** from the alternate call signaling (CS) list. At step **348**, a lightweight RRQ message is sent to the gatekeeper **204** on which the CS channel resides. This lightweight RRQ ressage is sent to a next gatekeeper **204** because the call signaling channel was lost, and not because a lightweight RRQ message was otherwise due. That is, this lightweight RRQ message is not sent as a

keep alive signal. At step **352**, a determination is made as to whether a response to the lightweight RRQ message, in the form of an RCF message, has been received from the gatekeeper **204**. If no response is received, it is retried. If still no response is received, the communication endpoint **104** determines whether an RRJ has been received (step **356**). If no RRJ is received, the communication endpoint **104** returns to step **344**. Alternatively, if the endpoint **104** receives an RRJ response from the gatekeeper **204**, it implies that the endpoint **104** is no longer registered with the switch, and thus the endpoint must restart the registration process (step **360**) (i.e., returns to step **300**).

If an RCF response from the gatekeeper **204** is received, it is very likely that the communication endpoint **104** will be able to establish a call signaling channel with the selected gatekeeper **204**. In addition, the receipt of an RCF message indicates that the communication endpoint **104** is still registered with the selected gatekeeper **204**. Accordingly, if an RCF message is received from the gatekeeper **204**, the communication endpoint **104** may proceed to re-establish a call signaling link with the selected gatekeeper **204** (step **364**). If at step **368** it is determined that the call signaling link has been successfully re-established, the procedure for re-establishing a lost call signaling link ends (step **372**). If the call signaling link is not successfully re-established, the communication endpoint **104** may return to step **344** to select a next gatekeeper **204** from the call signaling list.

With reference now to **Fig. 3C**, the steps taken by a communication endpoint **104** in order to re-establish a call signaling link in accordance with another embodiment of the present invention are shown. Accordingly, if at step **328** (**Fig. 3A**) it is determined that the signaling channel has been lost, a lightweight RRQ message is sent to n gatekeepers

204 simultaneously, where n is a number from 1 to the total number of gatekeepers **204** in the call signaling list (step **376**). Where n>1, faster recovery can be realized, however, additional network traffic is generated. Therefore, n should be selected so that an improved recovery time is balanced against the amount of additional network traffic that is generated. At step **380**, a determination is made as to whether a response (i.e., an RCF message) has been received from any of the gatekeepers **204**. If no response has been received from any listed gatekeeper **204**, the communication endpoint **104** determines whether an RRJ has been received (step **382**). If no RRJ is received, the endpoint **104** returns to step **376**. If an RRJ is received, the endpoint **104** can restart the registration process (step **384**). If a response is received from a gatekeeper **204**, one of the responding gatekeepers **204** (or the responding gatekeeper **204**) is selected (step **388**). At step **392**, the communication endpoint **104** attempts to establish a call signaling link with the selected gatekeeper **204**. A determination is then made as to whether the call signaling link has been successfully established (step **396**). If the link has been successfully established, the procedure for re-establishing a call signaling link ends (step **398**). If the call signaling link is not successfully established, the communication endpoint **104** may restart the registration process (step **384**).

As can be appreciated by one of skill in the art, the components of a communication arrangement utilizing the present invention may be combined with other components. For example, a gatekeeper **204** may be implemented as part of a platform that provides gateway and switching capabilities. In addition, it should be appreciated that the multiple gatekeepers **204** used by embodiment of the present invention may be implemented as part of a single server computer, switch or other network entity.

Likewise, a communication endpoint **104** may function as a gateway and/or a communication terminal. Furthermore, it should be appreciated that communications between terminal devices, for example a calling and a called telephone, may benefit from the present invention, even if such devices are not themselves part of a gatekeepers zone **200**. In particular, so long as a segment of a realtime communication is carried over an Internet protocol network between two communication endpoints **104** (*e.g.* gateways), the invention may be used to provide efficient recovery of a lost call signaling channel.

It should also be appreciated that, although examples are provided in connection with use of the H.323 protocol, the present invention is not so limited. In particular, the present invention may be applied to increase the efficiency with which a call signaling channel is re-established in connection with other protocols using a keep alive signal.

In addition, it should be appreciated that the disclosed call signaling recovery mechanism is standards based, as it uses messages that are defined by the H.323 standard. Accordingly, use of the disclosed technique does not require that new messages be defined. In addition, an endpoint **104** can incorporate the disclosed recovery mechanism, without requiring that any modifications be made to the gatekeeper **204**. Accordingly, any gatekeeper **204** that supports the H.323 standard can be used in connection with embodiments of the claimed invention.

The foregoing discussion of the invention has been presented for purposes of illustration and description. Further, the description is not intended to limit the invention to the form disclosed herein. Consequently, variations and modifications commensurate with the above teachings, within the skill and knowledge of the relevant art, are within the scope of the present invention. The embodiments described hereinabove are further

intended to explain the best mode presently known of practicing the invention and to enable others skilled in the art to utilize the invention in such or other embodiments with various modifications required by their particular application or use of the invention. It is intended that the appended claims be construed to include the alternative embodiments to the extent permitted by the prior art.